Instruction Handbook for....

AIL TYPE 124

POWER OSCILLATOR

June 1960

INSTRUMENT CENTER

CUTLER-HAMMER

AIRBORNE INSTRUMENTS LABORATORY
DEER PARK, LONG ISLAND, NEW YORK 11729

CONTROL AIL DIVISION

INSTRUCTION HANDBOOK FOR
AIL TYPE 124 POWER OSCILLATOR
P/N 12410

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AIRBORNE INSTRUMENTS LABORATORY
A DIVISION OF CUTLER-HAMMER, INC.
Deer Park, Long Island, New York

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FRONTISPIECE. TYPE 124 POWER OSCILLATOR

SECTION 1
GENERAL DESCRIPTION

1. GENERAL

The Type 124 Power Oscillator (Figures 1-1 and 1-2 provides signals at frequencies from 200 to 2500 Mc in three ranges; it delivers continuous-wave, sine-wave modulated, square-wave modulated, or (under certain conditions) pulse-modulated signals. An internal audio oscillator permits sine-wave modulation of the RF oscillator at either 400 cps or 1000 cps; an external oscillator can be used to drive the modulator at frequencies from 20 cps to 150 kc. External sources of square waves or pulses can also be used to modulate the oscillator. Pure pulse output is not obtainable under all conditions. This limitation is described more fully in Section 2, paragraph 4d.

2. DESCRIPTION

The Type 124 Power Oscillator is designed for either bench-top or standard relay-rack mounting (for rack mounting, the two side handles must be removed). It is housed in a single chassis. All connectors necessary for the operation of the unit are located on the front panel--with the exception of the AC input, which is located at the rear of the unit. Front-panel controls are provided for operation over the three ranges; to select a particular range, however, adjustments at the rear of the unit are necessary. The type of modulation is selected by means of a six-position switch on the front panel.

3. CHARACTERISTICS

a.	Frequency ranges (nominal)	200 to 500 Mc 300 to 900 Mc 900 to 2500 Mc
b.	Types of signal	Continuous wave; amplitude-modulated sine wave, square wave, and pulse (limited)
c.	RF power output (nominal)	In excess of 10 w at 200 Mc, 20 w at 600 Mc, 10 w at 1500 Mc, and 2.5 w at 2500 Mc
d.	Output impedance	50 ohms
e.	Power input	180 w at 115 volts, 50 to 60 cps
f.	Mounting	Standard relay rack, 10.5-inch high panel
g.	Weight	78 pounds

4. TUBE COMPLEMENT

Symbol	Type	Use
V101	6SN7	Audio oscillator
V102 (A)	6SN7	Pulse polarity changer
(B)	6SN7	Preamplifier
V103	807	Modulator
V104	5R4GY	High-voltage rectifier
V105	5R4GY	Low-voltage rectifier
V106	NE51 (neon)	Oscillator limiter
V107	2C39A	RF oscillator

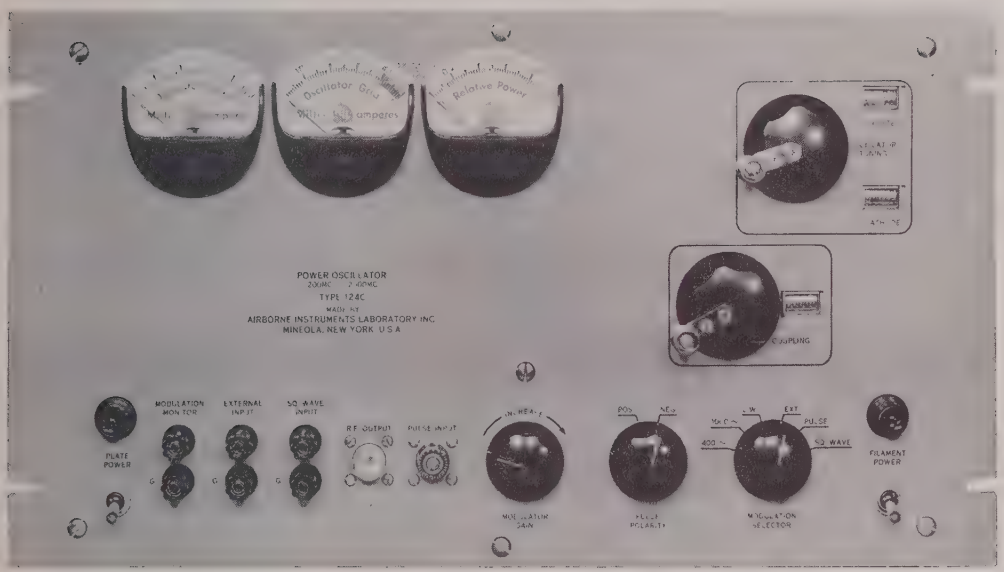
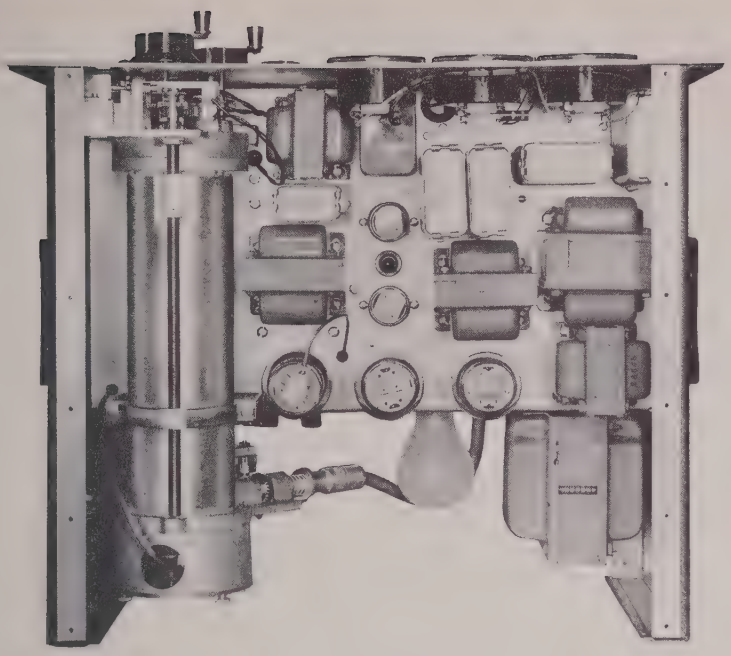
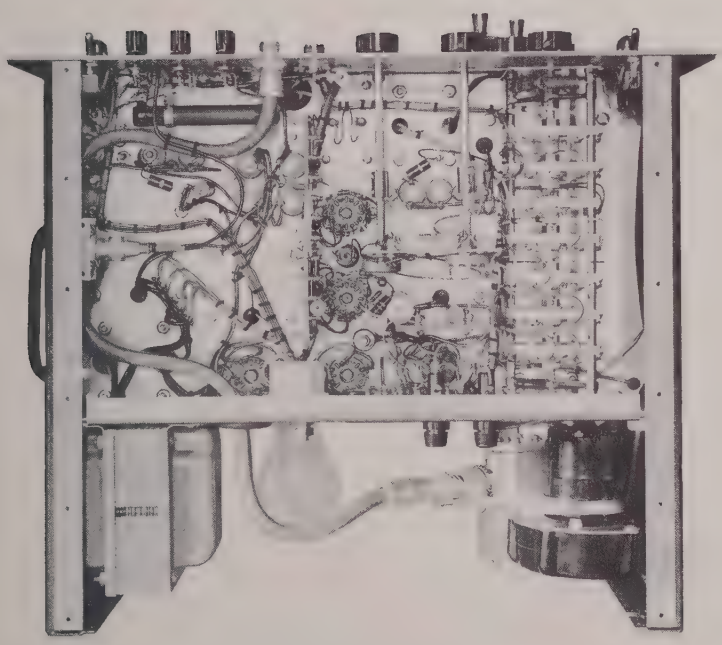


FIGURE 1-1. TYPE 124 POWER OSCILLATOR, FRONT VIEW



TOP VIEW



BOTTOM VIEW

FIGURE 1-2. TYPE 124 POWER OSCILLATOR, TOP AND BOTTOM VIEWS

SECTION 2
THEORY OF OPERATION

1. GENERAL

The Type 124 Power Oscillator (Figure 2-1) consists essentially of an RF oscillator, an AF oscillator, a modulator, and two power supplies.

2. RADIO-FREQUENCY OSCILLATOR

The source of RF power is a resonant-cavity oscillator built around a 2C39A disk-seal triode tube. The oscillator circuit is composed of adjustable coaxial lines.

a. STRUCTURE

The 2C39A tube (V107) is mounted coaxially within the cylindrical lines at the rear of the oscillator structure, which is closed by a metal end plate. The grid, plate, and cathode contact surfaces of the tube are contacted all the way around by spring contacts. The grid of the tube is connected directly to the end of the middle cylinder; the plate and cathode elements are connected to the outer and inner cylinders, respectively, through blocking capacitors C114 and C115.

Two plungers slide between the concentric lines to vary the lengths of the active portions of the lines that form resonant cavities. The plungers are driven by lead screws from the gear box and the main tuning knob. Provision is made for adjusting the grid-cathode (cathode) plunger independent of the grid-plate (plate) plunger by pushing in on the tuning knob; this operation disengages the plate-plunger drive. If the plungers are properly adjusted, the oscillator will operate on odd quarter-wavelengths.

b. MODES OF OSCILLATION

For the two low-frequency ranges (200 to 500 Mc and 300 to 900 Mc), the coaxial oscillator is operated on the fundamental ($\lambda/4$) mode; for the high-frequency range (900 to 2500 Mc), the cavity is operated on the $3\lambda/4$ mode. In either case, the setting of the plate plunger is the primary frequency determinant. For a given plate-plunger setting, however, there are always two settings of the cathode plunger that will produce oscillations--and there may be as many as four settings. These oscillations, which are quite distinct, correspond to the $\lambda/4$, $3\lambda/4$, $5\lambda/4$, and $7\lambda/4$ modes. On the low-frequency ranges, only the $\lambda/4$ mode and a weak $3\lambda/4$ mode appear; on the high-frequency range, all of the modes may appear. Because of this, it is necessary to adhere rather closely to the tuning curves (Figures 2-2, 2-3, and 2-4) to keep from working on an undesired frequency.

Some deviation from the average tuning curves occurs with different 2C39A tubes. Occasionally, it may be necessary to check the mode of oscillation with a frequency meter.

c. FEEDBACK ASSEMBLIES

The feedback coupling required to produce oscillation on the fundamental $\lambda/4$ mode (200 to 500 Mc and 300 to 900 Mc) is obtained from its respective assembly (Figure 2-5) that provides capacitive feedback. These assemblies consist of tabs in the plate cavity, connected through insulated probes to a ring in the cathode cavity.

Feedback coupling required to produce oscillation in the $3\lambda/4$ mode (900 to 2500 Mc) is obtained from an assembly (Figure 2-5) that provides inductive feedback. This assembly consists of three S-shaped loops; one loop of each "S" is in the cathode cavity, and the other loop is in the plate cavity. Only one of these assemblies is used at any one time; the unused assemblies are each held in a holder provided on the

inside surface of the rear access door. To change frequency ranges, it is necessary to disassemble the rear of the oscillator unit and to install the appropriate feedback assembly.

d. TUNING RANGE

The lowest frequency to which the oscillator can be tuned is determined by the mechanical limit of travel of the plate plunger away from the tube; this minimum frequency is about 180 Mc. The highest frequency at which the oscillator can be used is determined primarily by the limitations of the oscillator tube. Power output can be obtained as high as 2700 Mc, but the limit of useful output will vary considerably with different 2C39A tubes. Tubes should be selected for best performance at the high-frequency end of the tuning range.

e. TRACKING

The lead screws that drive the cathode and plate tuning plungers are geared in such a manner that nearly perfect tracking is accomplished over the entire $\lambda/4$ mode. Best results will be obtained if the cathode and plate plungers are aligned for optimum output at a reading of 5500 on the plate counter. With a load having a low SWR over the frequency range, single-dial operation from 300 Mc to over 800 Mc should be possible.

Tracking on the $3\lambda/4$ mode is not automatic, and it will usually be necessary to trim the adjustment of the cathode tuning every 100 to 200 Mc.

f. OUTPUT COUPLING

The RF output is coupled to the cavity by an adjustable probe. Maximum pickup is obtained by turning the coupling knob clockwise against its stop. Because the RF field within the cavity changes with frequency, pure capacitive coupling is not possible in the range from about 1250 to 1700 Mc. When operating in this range, inductive coupling is provided by

mounting a coupling loop (Figure 2-5) so that it is capacitively coupled to the probe. For satisfactory coupling above 1800 Mc, it is usually necessary to remove the coupling loop. The position of the coupling loop is adjusted from the rear of the oscillator unit by loosening the loop-retaining screw, sliding the loop in or out, and tightening the screw to hold it in position.

g. BLOWER CIRCUIT

The oscillator tube is cooled by forced air from blower B101. The blower motor starts when the FILAMENT POWER switch is turned on. Do not operate the unit if the blower does not start. (See Section 5, paragraph 1.)

h. CATHODE BALLAST RESISTOR

The oscillator-tube cathode bias resistor consists of a standard 40-watt Mazda lamp (R126), which has the property of increasing its resistance with increasing current. This provides an automatic bias that improves the stability of the oscillator.

i. METERS

The OSCILLATOR GRID and the OSCILLATOR PLATE meters indicate their respective currents when the unit is operating as a CW oscillator or when it is modulated by sine-wave signals. They are not in the circuit when the oscillator is being pulsed or modulated with square waves.

The RELATIVE POWER meter, in conjunction with micromatch coupler Z101, samples and converts RF power to a DC voltage that can be read on the RELATIVE POWER meter. This voltage indication has some proportional relationship to incident power. This differs from net power to the load by only about 10 percent for values of SWR as high as 2.0 and is considerably more accurate for lower values of SWR. Since the micromatch coupler is frequency-sensitive and the SWR of the load will vary over

the frequency range of the oscillator, a direct power calibration would be misleading. However, for matched-load conditions at any given frequency, an increase in the reading of the RELATIVE POWER meter will indicate an increase in power to the load in accordance with the relationship listed in Table II-1.

TABLE II-1

RF Power in Percent of Full Scale	Meter Deflection in Percent of Full Scale
0	00.0
5	13.6
10	22.9
15	30.9
20	37.4
25	43.1
30	48.5
40	57.7
50	65.7
60	73.1
70	80.1
80	87.0
90	93.7
100	100.0

3. AUDIO-FREQUENCY OSCILLATOR

The Type 124 Power Oscillator contains an AF oscillator (V101) that can be used to modulate the RF oscillator with either a 400- or a 1000-cps signal. This oscillator is turned on by means of the MODULATION SELECTOR switch (Figure 1-1). The AF oscillator is designed to produce a waveform relatively free from distortion.

4. MODULATION

The Type 124 Power Oscillator can be modulated with a variety of waveforms. The type of modulation is selected by means of the MODULATION SELECTOR switch on the front panel.

The degree of modulation for all positions of the MODULATION SELECTOR switch except SQ. WAVE is controlled by means of the MODULATION GAIN control.

a. AF MODULATION

Sine-wave modulation is provided by the internal AF oscillator when the MODULATION SELECTOR switch is turned to 400~ or 1000~. Modulation for the sine waveforms is of the parallel or Heising type and is accomplished by means of a type 807 tube (V103) and a modulation choke (L104). V102B is a preamplifier ahead of the modulator tube.

b. CW OSCILLATION

The Type 124 Power Oscillator will operate unmodulated to furnish CW oscillation when the MODULATION SELECTOR switch is turned to CW.

c. EXTERNAL MODULATION INPUT

With the MODULATION SELECTOR switch turned to EXT and an external source of modulation connected to the panel terminals marked EXTERNAL INPUT, the RF oscillator can be modulated at frequencies from 20 cps to 150 kc with at least 40 percent modulation. Modulation at frequencies as high as 950 kc is possible with a reduced modulation percentage. About 3 volts is required from the external source. The input impedance is 10,000 ohms.

d. PULSE MODULATION

For pulse operation, an external source of pulses must be connected to the panel receptacle marked PULSE INPUT. When the MODULATION SELECTOR switch is turned to PULSE, the

connections to V103 (a type 807 tube) are changed to make it a conventional pulse modulator. Between pulses, C112 is charged through R120; during this period, the modulator tube (V103) is biased near cutoff. The oscillator is also biased by means of a cathode resistor (R124). When the modulator is triggered, C112 is effectively placed between the oscillator-tube cathode and the ground, reducing the cathode bias and permitting the tube to oscillate.

At low frequencies (below 1500 Mc), it will be found that some CW oscillation occurs between pulses. On the $\lambda/4$ mode, the ratio of peak pulse power to CW power is about 2.2 to 1 at 300 Mc, rising to about 100 to 1 at 800 Mc. On the $3\lambda/4$ mode, the ratio will be about 200 to 1 at the low end (1000 Mc). Above 1500 Mc, no CW oscillation will occur (see Figure 2-6).

When pure pulse modulation is desired at frequencies below 1500 Mc, it is necessary to modify the pulsing circuit--at some sacrifice in ease of operation of the equipment. The 1000-ohm 2-watt oscillator cathode resistor (R124) is replaced with a 1000-ohm 25-watt variable resistor, and a 20,000-ohm 5-watt bleeder resistor is connected from +250 volts (from the low-voltage supply) to the oscillator cathode. The leads to the variable resistor must be kept short because the modulating pulse is applied across it.

In operation, the oscillator is tuned up first on CW. Then, with the MODULATOR GAIN control turned fully counter-clockwise, the MODULATION SELECTOR switch is turned to PULSE. Observing the indication of the RELATIVE POWER meter, the oscillator cathode bias should be increased by increasing the resistance in the cathode circuit to a point where the oscillator just stops oscillating. The pulse drive should now be increased (by turning the MODULATOR GAIN control clockwise) until the oscillator starts pulsing. The proper

bias is quite critical and will be different for different operating frequencies. With the bleeder bias arrangement, it will be found that at the low end of the $\lambda/4$ mode the oscillator will not pulse on very short pulses. At 300 Mc, the minimum pulse length that will give a good output pulse will be about 10 μsec; at 600 Mc, the minimum will be about 5 μsec. On the $3\lambda/4$ mode, the oscillator will operate on pulses as short as 0.5 μsec. Figure 2-7 shows the minimum pulse length that can be obtained with this modification.

e. EXTERNAL SQUARE-WAVE INPUT

The modulator tube (V103) is not used for square-wave modulation. Instead, an external square-wave generator (such as the Hewlett-Packard Model 210) is connected to the panel posts marked SQ. WAVE INPUT, and the MODULATION SELECTOR switch is turned to SQ. WAVE. To modulate the oscillator, about 10 volts at 1000-ohms impedance is required. (NOTE: The SQ. WAVE INPUT is in parallel with the oscillator cathode resistor.) If the square-wave source has a low DC resistance, or if it places a direct voltage across the terminals, the operating characteristics of the oscillator will be changed. The DC resistance can be increased by inserting an external resistor in series with the input (1000 ohms will be sufficient). With the Hewlett-Packard Model 210 square-wave generator, direct voltages exist between the outer output terminals and the center. If the two outer terminals are used, these direct voltages will be canceled. It is not possible to use a blocking capacitor in series with the input. If a small capacitor is used, differentiation of the square wave will take place. A large capacitor may cause the oscillator to self-pulse.

5. HIGH-VOLTAGE POWER SUPPLY

The high-voltage power supply consists of one winding on the power transformer (T101), a full-wave type 5R4GY rectifier tube (V104), and associated filter choke and capacitors.

This circuit supplies 600 volts to the RF oscillator and modulator plates. Bleeder resistors (R127 and R128) provide a tap at 280 volts to supply the screen of the modulator tube (V103).

6. LOW-VOLTAGE POWER SUPPLY

The low-voltage power supply consists of a winding on T101, a full-wave type 5R4GY rectifier tube (V105), and associated filter choke and capacitors. The bleeder resistance (R129 and R130) is grounded at the junction. The low-voltage supply feeds +250 volts to the audio oscillator (V101), the pulse-polarity-changer tube (V102A), and the modulator preamplifier (V102B). In addition, it supplies a negative bias to the modulator tube (V103) when the oscillator is pulsed.

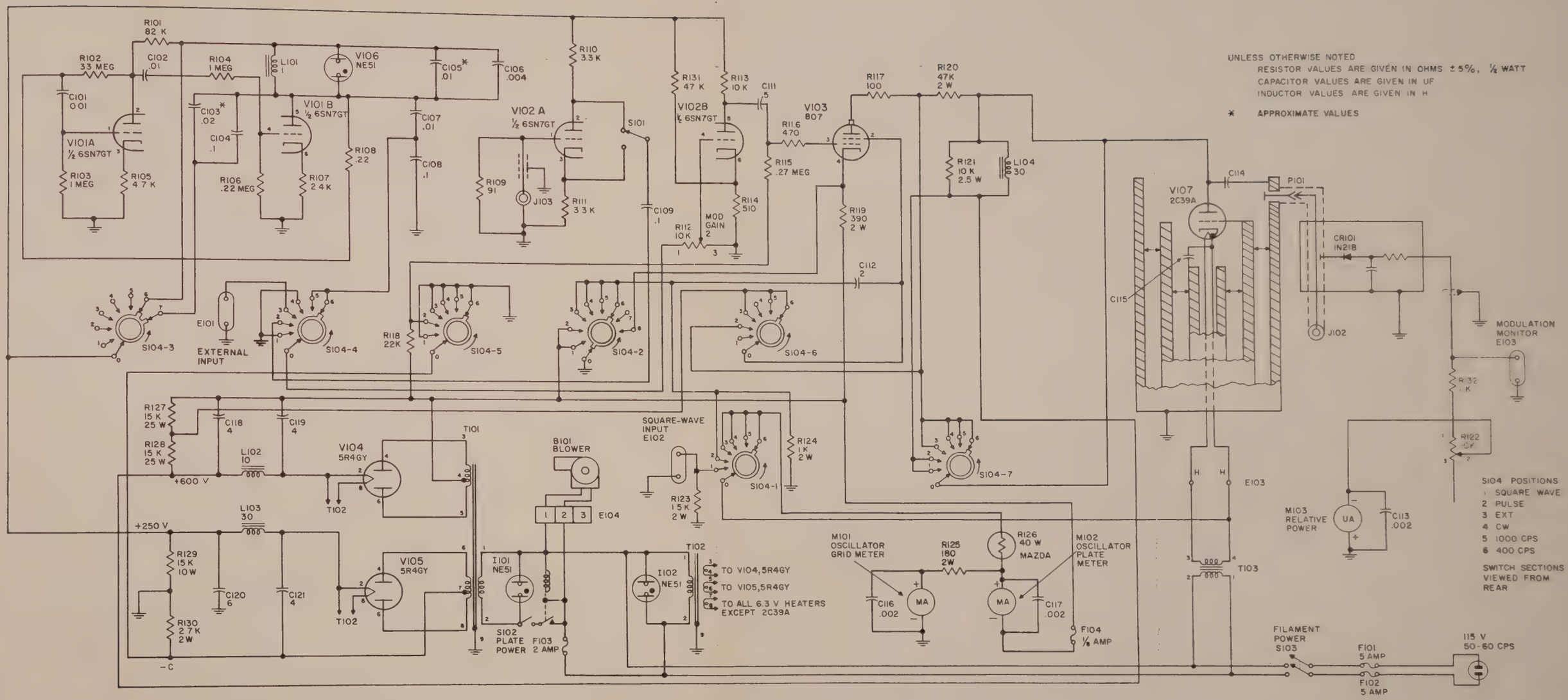


FIGURE 2-1. TYPE 124 POWER OSCILLATOR, SCHEMATIC DIAGRAM

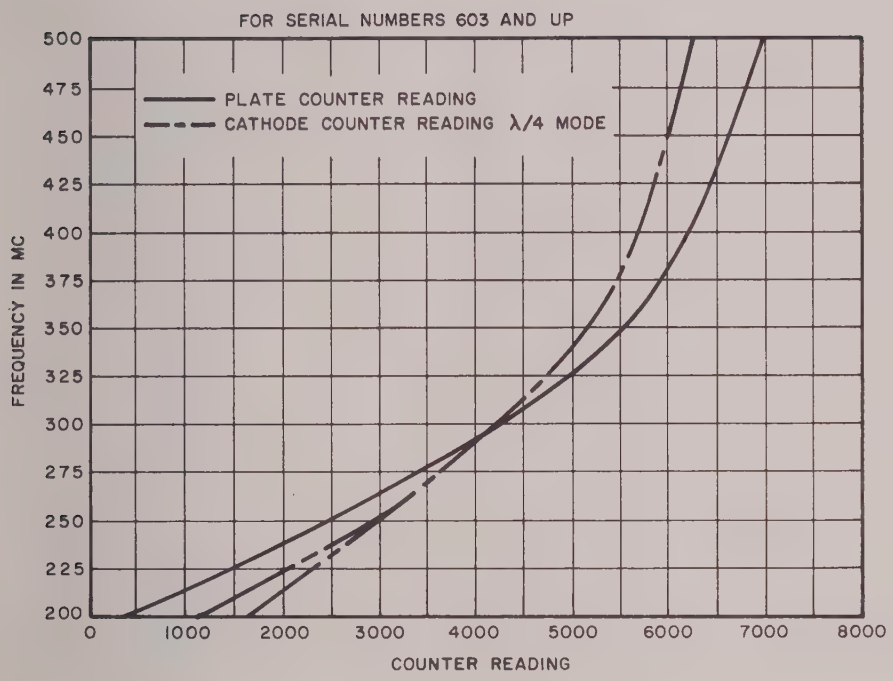


FIGURE 2-2. TUNING CURVE FOR LOW-LOW-FREQUENCY RANGE

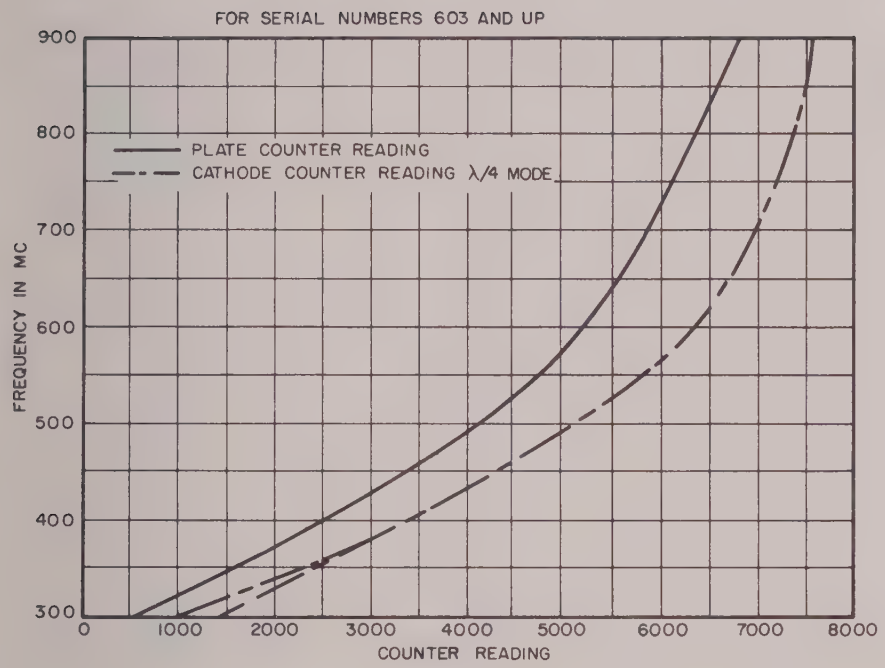


FIGURE 2-3. TUNING CURVE FOR LOW-FREQUENCY RANGE

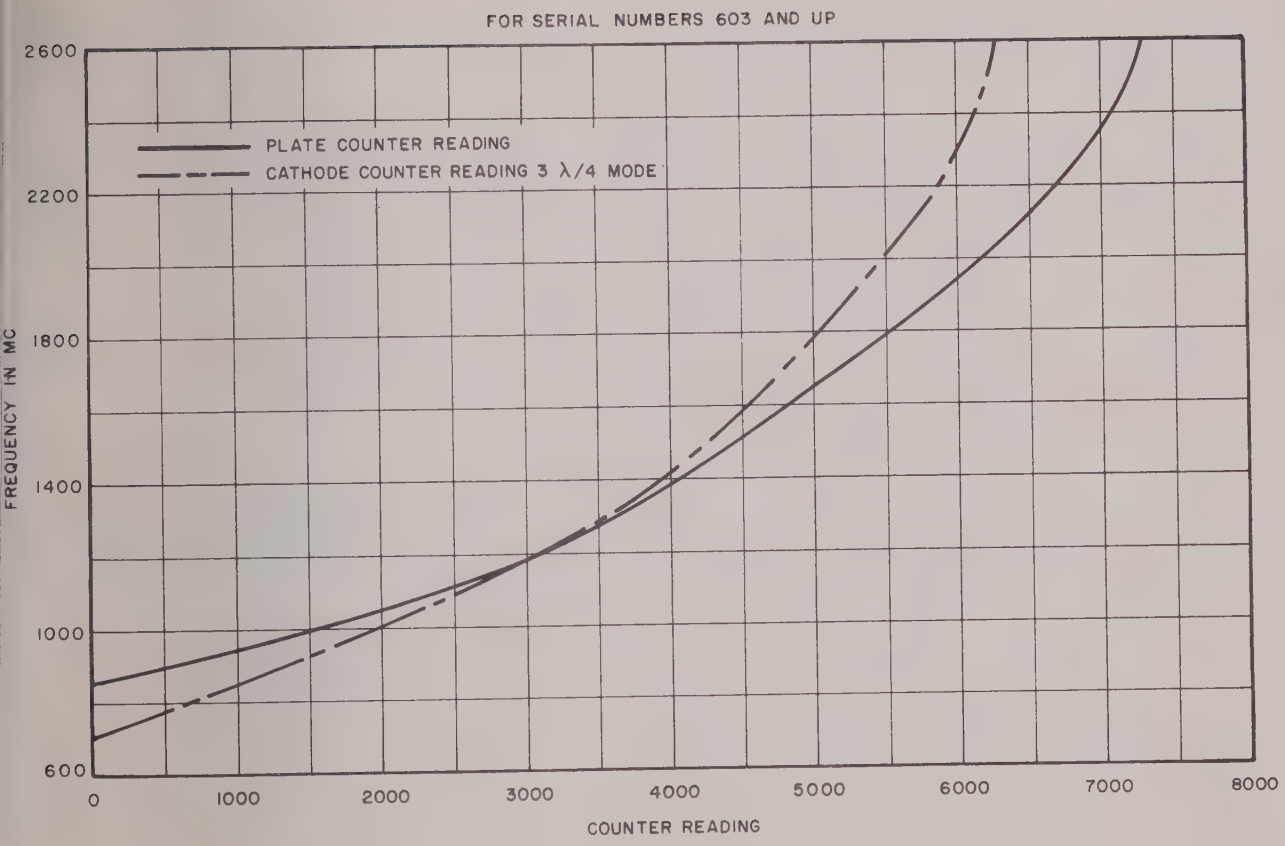


FIGURE 2-4. TUNING CURVE FOR HIGH-FREQUENCY RANGE

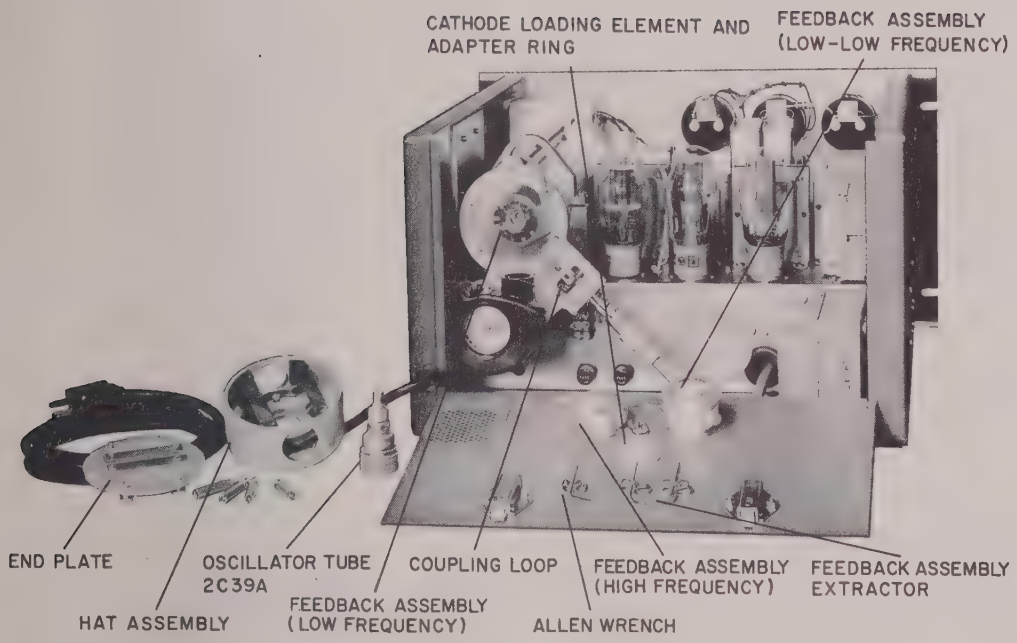


FIGURE 2-5. TYPE 124 POWER OSCILLATOR, REAR VIEW

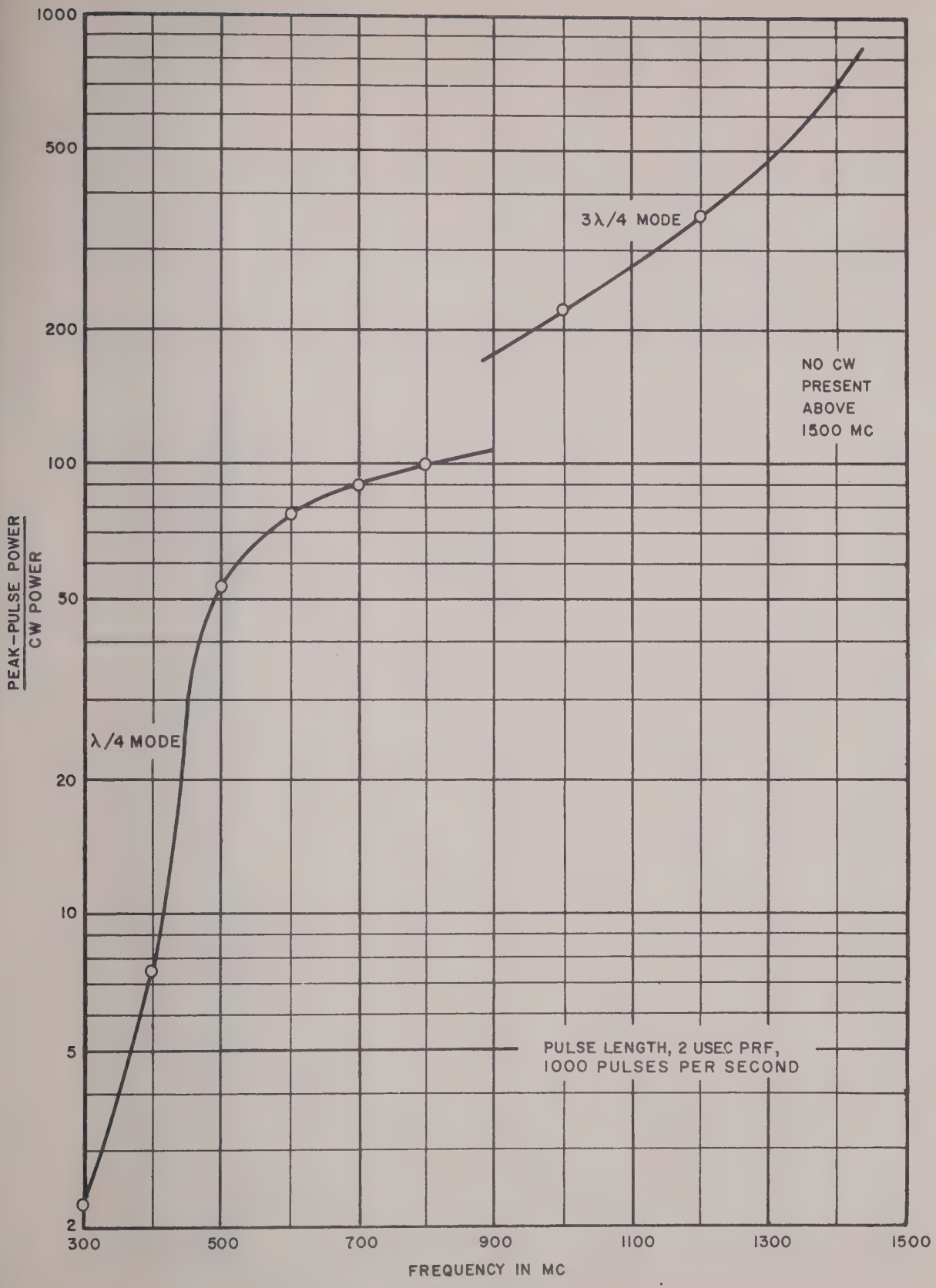


FIGURE 2-6. PULSING CHARACTERISTIC OF TYPE 124 POWER OSCILLATOR

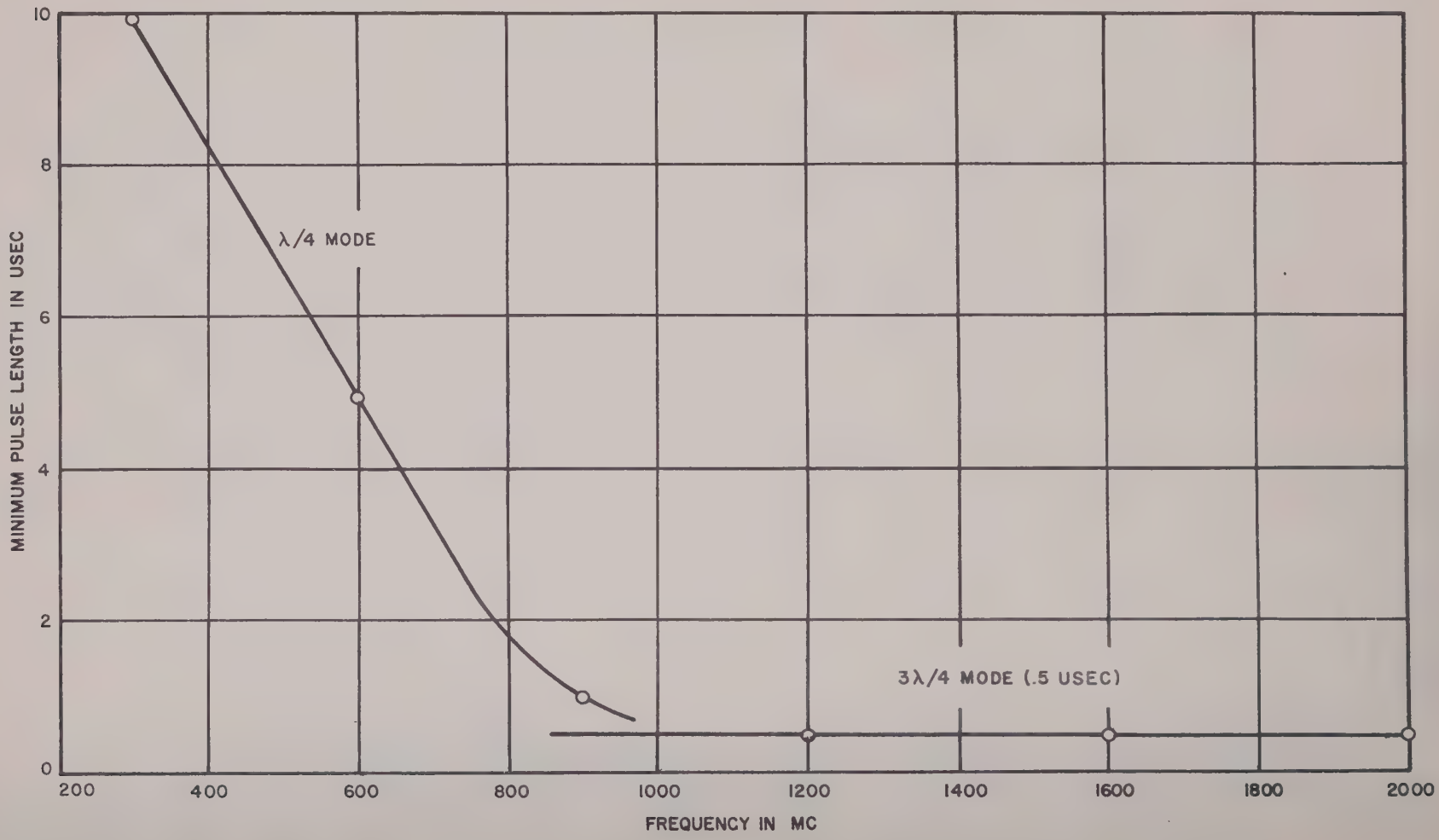


FIGURE 2-7. MINIMUM PULSE LENGTH OBTAINABLE WITH MODIFIED CIRCUIT

SECTION 3

INSTALLATION

1. GENERAL

The equipment is packed in a single unit. The AC line cord and connectors for the RF output and pulse input are supplied with the equipment.

2. INSPECTION

Before installation, open the access door by releasing the two fasteners at the rear of the unit and examine the equipment for possible damage in shipment. Examine the tubes to see that they are firmly seated in their respective sockets. Inspect the 2C39A oscillator tube (V107) (see Figure 2-5). The procedure for removing the oscillator tube from the cavity unit is given in Section 4, paragraph 5 [steps a(1) and a(2)].

The equipment is shipped with the high-frequency feedback assembly installed. Note that the other frequency feedback assemblies are each screwed on holders mounted on the inside surface of the access door. The special wrench for changing the feedback assemblies is similarly mounted. To change the feedback assemblies, remove the hat assembly on the rear of the cavity unit in accordance with the instructions for this procedure given in Section 4, paragraph 5.

3. INSTALLATION

The equipment can be operated on a bench or mounted in a standard rack. To be mounted in a rack, the two handles must be removed; the unit is then secured to the rack by four 10-24 machine screws and washers; the access door permits all

necessary adjustments to be made without removing the equipment from the rack.

CAUTION

Before inserting the AC line plug to the power source, make sure that both toggle switches (FILAMENT POWER and PLATE POWER) on the panel are in the OFF (down)position.

NOTE: The Type 124 Power Oscillator is designed for operation on 115 volts, 50 to 60 cps only. Connection to a power source of other voltage or frequency may result in damage to the equipment.

4. LOAD

Connect a suitable load (preferably not less than 40 feet of RG-21/U or RG-21/AU lossy 50-ohm coaxial cable) to the R.F. OUTPUT receptacle. If this type of load is not available, a long length (100 feet or more) of RG-8/U or RG-9/U cable can be used. An antenna or other dissipative load having an SWR of less than 5 in the desired frequency range can also be used.

CAUTION

Do not attempt to operate the oscillator without some RF load connected.

In all cases where more RF power is available than is needed for a particular application, it is recommended that a length of lossy 50-ohm cable (RG-21/AU or RG-21/U) be used between the oscillator and the load. This will ensure more stable operation when the frequency is changed over wide limits.

SECTION 4

OPERATION

1. PRE-OPERATION PROCEDURE

a. Turn the MODULATION SELECTOR switch to C.W. position.

b. Refer to the calibration curves (Figures 2-2, 2-3, and 2-4), and select a PLATE counter reading and a CATHODE counter reading in the frequency range being used. Turn the OSCILLATOR TUNING knob until the PLATE counter reading is correct. Then disengage the plate plunger by pressing in on the knob, and turn it to set the CATHODE counter reading.

c. Reduce the coupling to minimum by turning the COUPLING knob counterclockwise to a zero reading on the COUPLING counter.

CAUTION

Do not attempt to operate the oscillator without some RF load connected.

2. STARTING EQUIPMENT

a. Turn on the FILAMENT POWER switch. The pilot lamp above the switch and all vacuum-tube filaments should light.

b. To permit the 2C39A (V107) cathode to reach operating temperature before plate voltage is applied, a time delay switch is installed (delay, approximately 2 minutes), then turn on the PLATE POWER switch. The pilot lamp above the switch should light. Do not operate the unit if the blower does not start. When the oscillator is functioning, readings on both the OSCILLATOR GRID meter and the OSCILLATOR PLATE meter will be observed.

3. OSCILLATOR ADJUSTMENT

a. Observing the OSCILLATOR GRID meter, tune the cathode line (press in on the OSCILLATOR TUNING knob) for maximum grid current. This should not exceed 40 ma. The reading of the CATHODE counter should agree closely with that obtained from the calibration chart. Points very far off may represent another mode of oscillation, resulting in a different oscillator frequency.

CAUTION

When operating in the 200 to 500 Mc range with its associated feedback assembly, cathode loading element, and probe-adapter ring, do not increase the CATHODE counter setting to a point above 06500, and do not decrease the COUPLING counter setting to a point below 00700.

b. After maximum grid current has been obtained, increase the coupling (turn the COUPLING knob clockwise) until the grid current is reduced to about one-half this maximum value. The loaded grid current should ordinarily be between 20 and 30 ma. Modulation and power output will suffer if the grid current is allowed to exceed 40 ma or fall below 10 ma.

CAUTION

Grid currents should not be permitted to exceed 40 ma for periods of longer than 10 seconds.

4. FREQUENCY-RANGE SETTINGS FOR RF OSCILLATOR

The equipment is shipped with the high-frequency feedback assembly in place. To operate the equipment from 200 to 500 Mc or from 300 to 900 Mc, it will be necessary to

change the feedback assembly. The following table shows the feedback assembly and output-coupling-loop adjustments required for operation at various frequencies.

FREQUENCY-RANGE SETTINGS

Frequency Range (Mc)	Feedback Assembly Required	Position of Coupling Loop
200 to 500	Capacitive (low-low frequency)	Out of cavity
300 to 900	Capacitive (low frequency)	Out of cavity
900 to 1250	Inductive (high frequency)	Out of cavity
1250 to 1700	Inductive (high frequency)	In cavity
1700 to 2500	Inductive (high frequency)	Out of cavity

5. CHANGING RANGES

To change the frequency feedback assemblies, proceed according to the following instructions.

a. LOW- AND HIGH-FREQUENCY FEEDBACK ASSEMBLIES

(1) Remove the metal end plate from the rear of the unit.

(2) Grasp the 2C39A tube by the cooling fin and pull it out, using a clockwise twist to loosen the tube from the contact springs.

(3) Disconnect the plate lead by loosening the contact screw.

(4) Remove the oscillator hat assembly (Figure 2-5) by unscrewing the four stud bolts that hold the hat assembly to the outer cylinder.

CAUTION

Do not loosen the screws in the bakelite blocks; if you do, you may damage the mica capacitor assembly.

(5) Loosen the three Allen-head setscrews that lock the feedback assembly in place.

(6) Make sure that the coupling probe and loop are out of the way, and remove the feedback assembly by unscrewing it with the special U-shaped extractor provided.

(7) Screw the desired feedback assembly into place on the cylinder (when installing the low-low-frequency feedback assembly, see paragraph b below). Adjust the feedback assembly so that the output probe and coupling loop will not strike the feedback assembly when coupling is increased. A fourth setscrew in each feedback assembly acts as a stop to limit the distance that the feedback assembly can be screwed in. The back surface of the feedback assembly will be about 3/8 inch in beyond the end of the cylinder.

(8) Tighten the Allen-head setscrews that lock the assembly in place.

(9) Replace the hat assembly. Replace the tube by gently inserting it and twisting it one-quarter turn in a clockwise direction.

(10) Connect the plate voltage lead.

(11) Replace the end-plate assembly.

b. LOW-LOW-FREQUENCY FEEDBACK ASSEMBLY

(1) To install the low-low-frequency feedback assembly, follow steps 1 through 6 in paragraph 5a above.

(2) Before screwing the assembly into place, push the cathode loading element onto the cathode line (closed end first) until the inner hub face of the cathode element is aligned with the shoulder under the nut at the end of the cathode line.

(3) Clip the output probe-adapter ring firmly over the output probe disk. (The COUPLING counter setting must be above 00700.)

(4) Continue with steps 7 through 11 above.

(5) To remove the components of the low-low feedback assembly from the oscillator cavity, proceed as instructed in steps 1 through 6, above; then grasp the inner

groove in the cathode loading element with the special U-shaped extractor provided, and pull it out; also unclip the output probe-adapter ring.

c. COUPLING LOOP

(1) To insert the coupling loop, loosen the screw that holds it (Figure 2-5), and push the loop up into the cavity as far as the slot allows it to go. Tighten the screw.

(2) To remove the loop, loosen the screw and pull the loop down as far as it will go. Tighten the screw.

6. MODULATION ADJUSTMENTS

a. INTERNAL AF MODULATION

Reduce the gain to minimum by turning the MODULATOR GAIN control fully counterclockwise. Turn the MODULATOR SELECTOR switch to 400~ or 1000~. Turn the MODULATOR GAIN control clockwise until the desired degree of modulation is reached. As the modulator gain is increased, a point will be noted where the readings on the OSCILLATOR GRID and OSCILLATOR PLATE meters will change. When this occurs, it is an indication that the oscillator is being overmodulated. Operation at or beyond this point will result in excessive distortion. To observe the modulating waveform, connect an oscilloscope to the MODULATION MONITOR terminals provided on the front panel.

b. EXTERNAL MODULATION

Connect an external AF oscillator to the panel terminals marked EXTERNAL INPUT. Turn the MODULATION SELECTOR switch to EXT. The percentage modulation is controlled by means of the MODULATOR GAIN control.

c. PULSE MODULATION

Connect an external pulse generator to the receptacle marked PULSE INPUT. Turn the MODULATION SELECTOR switch to

C.W., and tune the oscillator to the desired frequency (see paragraph 3 of this section). Turn the MODULATION SELECTOR switch to PULSE. Turn the PULSE POLARITY switch to POS or NEG., depending upon the polarity of the input pulses being used. The pulse drive to the modulator can be adjusted by means of the MODULATOR GAIN control. In general, this control can be turned to maximum. However, on some frequencies, an improvement in the shape of short pulses may result when the drive is less than maximum. By observing the rectified output of the oscillator (MODULATION MONITOR), it may be possible to improve the pulse shape somewhat by slight adjustments of the oscillator CATHODE plunger and/or the COUPLING knob.

d. SQUARE-WAVE MODULATION

Connect an external source of square waves to the panel terminals marked SQ. WAVE INPUT. Turn the MODULATION SELECTOR switch to C.W., and tune the oscillator to the desired operating frequency. Turn the MODULATION SELECTOR switch to SQ. WAVE.

SECTION 5

MAINTENANCE AND TROUBLESHOOTING

1. GENERAL

No special maintenance is required on the equipment, except to lubricate the blower motor. The blower motor requires lubrication at two points, at least every three months. Before starting the motor, add four drops of light motor oil to each of the oil wells. Relubricate the motor every month, or more often, if the ambient conditions require it. As an aid in troubleshooting and repair, tables of average resistance and voltage measurements are included. Variations of from 10 to 15 percent from the values in the tables may be expected.

2. REPLACEMENT OF OSCILLATOR TUBE

To replace the oscillator tube (2C39A) in the cavity unit, proceed as follows:

(1) Open the hinged door at the rear of the unit.

(2) Remove the metal end plate from the rear of the cavity unit by loosening the four thumb-knurled captive screws.

(3) Grasp the defective tube by the cooling fins, and gently twist and withdraw the tube from the cavity.

(4) Grasp the new tube by the cooling fins, and gently press-fit the tube into the cavity unit as far as possible.

(5) Replace the end plate at the rear of the cavity unit, and tighten the captive screws finger-tight.

(6) Close the door.

(7) LET TUBE COOK IN FOR 24 HOURS.

3. REPAIR

When trouble occurs in the Type 124 Power Oscillator, isolate it to a specific circuit by using normal servicing techniques. Then make voltage and resistance checks using the appropriate tables in this section. Variations of from 10 to 15 percent from the indicated values may be expected. After a defective part is repaired and/or replaced, the portion of the equipment that is affected should be thoroughly rechecked visually, mechanically, and electrically to verify the proper operating condition of the component.

WARNING

This equipment uses dangerous high voltages that can be fatal if contacted. Extreme caution must be exercised when working on the equipment.

4. REMOVAL

Methods for removal of any component will be obvious after a visual examination of the equipment. To remove the top or bottom cover, turn the self-tapping screws along the sides and back edges; also turn one upper center or lower center screw on the front panel, depending on which cover is to be removed.

5. DEPTH SETTING OF FEEDBACK ASSEMBLY

If the factory-set positioning screw sealed with Glyptol has become loose, a resetting is necessary. For the low-frequency feedback assembly (300 to 900 Mc) or the high-frequency feedback assembly (900 to 2500 Mc), proceed as follows:

(1) Remove the oscillator-tube top-hat assembly and retract the coupling probe all the way out.

(2) Retract the three evenly spaced setscrews on the feedback assembly, and install the feedback assembly in the cavity.

(3) Rotate the feedback assembly until its back surface is 3/8 ± 1/32 inch from the top-hat mounting surface and its position is such that two of the protruding tabs, or loops in the case of the high-frequency assembly, are equally spaced on either side of the coupling probe when the probe is engaged.

(4) After the feedback assembly has been correctly positioned, tighten the positioning screw until it contacts the end of the cylinder.

(5) Carefully remove the feedback assembly, making sure that the positioning-screw setting is not disturbed.

(6) Seal this setting with a drop of Glyptol.

For the low-low-frequency feedback assembly (200 to 500 Mc), whose configuration is different than the other feedback assemblies, the setting of the positioning screw is as follows:

(1) Retract the three evenly spaced setscrews on the feedback assembly.

(2) Install the cathode loading element (Part No. 124-4A104) by sliding it over the end of the cathode line (closed side inward) until the inner hub face of the cathode element is aligned with the shoulder under the hexagonal nut at the end of the cathode line.

(3) Clip the probe-adapter ring (Part No. 124-4A105) (see Figure 5-1) over the coupling probe; then retract the coupling probe enough to prevent the adapter from falling off. (The coupling counter reading should not be less than 00700.)

(4) Carefully determine where the threads engage the cylinder, mount the feedback assembly, and turn it clockwise 4-1/3 turns. The tabs should be positioned equally on both sides of the coupling-probe adapter.

(5) Replace the top-hat assembly and the 2C39A oscillator tube.

(6) Connect the RF output to a suitable 50-ohm load.

(7) Set the PLATE counter to 00000 and the CATHODE counter to 00500.

(8) Turn on the power and allow the equipment to warm up.

(9) Determine the operating frequency of the oscillator with a frequency meter. If the frequency is from 190 to 195 Mc, the feedback assembly is correctly positioned. If the frequency is below 190 Mc, reposition the feedback assembly by rotating it clockwise an additional 1/3 turn. If the frequency is above 195 Mc, rotate the feedback assembly outward 1/3 turn. If the oscillator falls outside of the acceptable 190 to 195 Mc range, resetting of the feedback assembly slightly in either direction can be attempted. In no case should the assembly be positioned so that there is a possibility of the tabs interfering with the coupling probe.

(10) When the correct position of the feedback assembly has been determined, tighten the positioning Allen-head setscrew until it contacts the end of the cylinder.

(11) Carefully remove the feedback assembly without disturbing the setscrew setting. Seal this setting with a drop of Glyptol.

6. COUNTER CALIBRATION

If the cavity is removed from the unit and the PLATE and CATHODE counters have been disturbed, a recalibration is necessary to maintain the usefulness of the tuning curves (Figures 2-2, 2-3, and 2-4).

The PLATE and CATHODE counters are set as follows:

(1) Rotate the tuning knob counterclockwise until both plate and cathode plungers reach their mechanical stops.

(2) Disengage each counter and rotate the numbers toward 00000. Set the counter five numbers below zero--that is, at 99995; then re-engage the counter. With the oscillator in normal operating condition, check to see that the indicated counter reading for a particular frequency of operation agrees with the tuning curve to within ± 2 percent.

(3) To set the COUPLING counter, simply rotate the counter knob clockwise until the coupling probe is withdrawn from the cavity to its maximum limit. Disengage the counter and set it to read 00000; then re-engage the counter.

7. TROUBLE ANALYSIS OF CAVITY

Symptom	Probable Cause	Remedy
Reduced power output	1. Weak 2C39A oscillator tube.	Replace.
	2. Feedback assembly improperly installed.	Check and re-install according to instructions in paragraph 4-5.
	3. Feedback assembly tab or tabs broken.	Repair or replace feedback assembly
	4. Coupling loop not in proper position for frequency range of operation.	See paragraph 4-4 and paragraph 2-2f for correct use.
	5. Coupling not optimum.	Increase or decrease COUPLING counter setting.
	6. Cathode tuning incorrect.	Check CATHODE counter setting for frequency of operation.
	7. Cathode loading element or adapter ring incorrectly installed when operating on low-low-frequency range (200 to 500 Mc).	See paragraph 4-5b for correct installation.
Squegging	1. Improper tracking of plate or cathode-line. Oscillator is operating on wrong mode.	Use recommended PLATE and CATHODE counter settings (see Figures 2-2, 2-3, or 2-4).
	2. SWR of load too high for particular frequency of operation.	Check and adjust.

Symptom	Probable Cause	Remedy
Erratic tuning	Foreign matter in cavity.	a. Open end of cavity, and retract plate and cathode plungers. Brush or blow out cavity. b. Clean spring contacts with cleaning fluid (trichlor-ethylene recommended). c. Remove any silver chips caused by feedback assembly setscrews cutting into edge of grid cylinder.
Excessive OSCILLATOR GRID and OSCILLATOR PLATE meter indications	1. Feedback assembly not inserted far enough.	Screw feedback assembly in until it contacts positioning-setscrew stop.
	2. Load disconnected or SWR of load too high.	Check and adjust.
	3. Improper coupling or tuning.	Check and adjust.
No indication on OSCILLATOR GRID and OSCILLATOR PLATE meters under normal conditions	1. Fuse F104 blown (if trouble persists, 2C39A oscillator tube is defective).	Replace.
	2. Defective R126 (40-w bulb).	Replace.
	3. Cavity not oscillating.	Retune; check PLATE and CATHODE counter settings.

Symptom	Probable Cause	Remedy
No RELATIVE-POWER meter indication	1. Defective meter.	Disconnect and apply current no greater than 200 μa. Repair or replace if necessary.
	2. Crystal mounting cap on micromatch coupler Z101 loose or disconnected.	Check and tighten.
	3. Defective 1N21B crystal.	Unscrew knurled cap and replace crystal.
Above 5 ma indication on OSCILLATOR GRID meter when only filament power is on	Filament leads to cavity have been interchanged	Interchange black and brown filament wires on insulated terminals located on forward left-hand portion of cavity.

8. VOLTAGE MEASUREMENTS

TUBE		PIN NUMBER							
Symbol	Type	1	2	3	4	5	6(A)	7	8
V101	6SN7(B)	0	170	8	0	270	12	6.3 AC(C)	6.3 AC(C)
V102	6SN7	0	280	12	0	210	7	6.3 AC(C)	6.3 AC(C)
V103	807	6.3 AC(D)	280(E)	0(F)	22(H)	6.3 AC(D)	550(G)	-	-
V104	5R4GY	-	600	-	-	-	-	-	600
V105	5R4GY	-	300	-	-	-	-	-	300
V106	NE51(B)	280	280	-	-	-	-	-	-

NOTE: Direct voltage to chassis is measured with 20,000-ohm-per-voltmeter. Unless otherwise noted, MODULATION SELECTOR switch is on 400~. Equipment is operating at 600 Mc.

(A) Plate cap on V103.

(B) All direct voltages zero when MODULATION SELECTOR switch is on C.W., EXT., PULSE, or SQ. WAVE.

(C) Measured with AC voltmeter between pins 7 and 8.

(D) Measured with AC voltmeter between pins 1 and 5.

(E) Zero when MODULATION SELECTOR switch is on C.W. or SQ. WAVE; 360 v when switch is on PULSE.

(F) -47 v when MODULATION SELECTOR switch is on PULSE.

(G) 600 v when MODULATION SELECTOR switch is on C.W. or SQ. WAVE; 360 v when switch is on PULSE.

(H) Zero when MODULATION SELECTOR switch is on C.W., PULSE, or SQ. WAVE.

9. RESISTANCE MEASUREMENTS

TUBE		PIN NUMBER							
Symbol	Type	1	2	3	4	5	6(A)	7	8
V101	6SN7	1 M	80 K (B)	4.7 K	0.22 M	11 K (B)	2.4 K	Inf	Inf
V102	6SN7	91	15 K	3:3 K	0-10 K (C)	20 K	500	Inf	Inf
V103	807	Inf	15 K (D)	300 K	600 (E)	Inf	30 K (F)	-	-
V104	5R4GY	-	30 K	-	280	-	280	-	30 K
V105	5R4GY	-	11 K	-	110	-	110	-	11 K

NOTE: Resistances are in ohms, measured to chassis. Unless otherwise noted, MODULATION SELECTOR switch is set on 400~. Equipment is not operating.

(A) Plate cap on V103.

(B) Infinite when MODULATION SELECTOR switch is on C.W., EXT., PULSE, or SQ. WAVE.

(C) As MODULATOR GAIN control is rotated clockwise.

(D) Infinite when MODULATION SELECTOR switch is on C.W. or SQ. WAVE; 75 k when switch is on PULSE.

(E) Zero when MODULATION SELECTOR switch is on PULSE; 390 ohms when switch is on SQ. WAVE.

(F) 75 k when MODULATION SELECTOR switch is on PULSE or SQ. WAVE.

10. TABLE OF REPLACEABLE PARTS

SYMBOL	DESCRIPTION	RATING
Blower		
B101	Continuous duty	115 v AC, 60 cps
Capacitors		
C101	0.01 μf, paper	400 v
C102	0.01 μf, paper	400 v
C103	0.02 μf, paper	400 v
C104	0.1 μf, paper	400 v
C105	0.01 μf, paper	400 v
C106	4000 μμf, mica	500 v
C107	0.01 μf, paper	400 v
C108	0.1 μf, paper	400 v
C109	0.1 μf, paper	400 v
C111	0.5 μf, paper	400 v
C112	2 μf, oil	1000 v
C113	2000 μμf, mica	500 v
C114	Oscillator plate bypass capacitor within oscillator assembly	
C115	Oscillator plate bypass capacitor within oscillator assembly	
C116	2000 μμf, mica	500 v
C117	2000 μμf, mica	500 v
C118	4 μf, oil	1000 v
C119	4 μf, oil	1000 v
C120	6 μf, oil	600 v
C121	4 μf, oil	600 v
Crystal		
CR101	1N21B	

SYMBOL	DESCRIPTION	RATING
Fuses		
F101 and F102	Line fuse	5 amp, 4 AG
F103	Plate power fuse	2 amp, 4 AG
F104	Meter fuse	1/8 amp, 4 AG
Indicators		
I101	Neon lamp NE51	
I102	Neon lamp NE51	
Receptacles		
J102	RF output receptacle (UG-22/U)	
J103	Pulse input receptacle (SO-239)	
Chokes		
L101	Oscillator inductor	1 h
L102	Filter choke	10 h, 200 ma
L103	Filter choke	30 h, 100 ma
L104	Modulation choke	30 h, 100 ma
Meters		
M101	Oscillator grid meter	0-50 ma
M102	Oscillator plate meter	0-150 ma
M103	Relative power indicator	0-200 μa
Plugs		
P101	Oscillator output plug (UG-21/U)	
Resistors		
R101	92 k, carbon	1/2 w, 10%
R102	0.33 meg, carbon	1/2 w, 10%

SYMBOL	DESCRIPTION	RATING
R103	1 meg, carbon	1/2 w, 10%
R104	1 meg, carbon	1/2 w, 10%
R105	4.7 k, carbon	1/2 w, 10%
R106	0.22 meg, carbon	1/2 w, 10%
R107	2.4 k, carbon	1/2 w, 10%
R108	0.22 meg, carbon	1/2 w, 10%
R109	91 ohms, carbon	1/2 w, 10%
R110	3.3 k, carbon	1/2 w, 10%
R111	3.3 k, carbon	1/2 w, 10%
R112	10 k, potentiometer	2 w, 20%
R113	10 k, carbon	1/2 w, 10%
R114	510 ohms, carbon	1/2 w, 10%
R115	0.27 meg, carbon	1/2 w, 10%
R116	470 ohms, carbon	1/2 w, 10%
R117	100 ohms, carbon	1/2 w, 10%
R118	22 k, carbon	1/2 w, 10%
R119	390 ohms, carbon	2 w, 10%
R120	47 k, carbon	2 w, 10%
R121	10 k, wirewound	25 w, 10%
R122	10 k, potentiometer	2 w, 20%
R123	1.5 k, carbon	2 w, 10%
R124	1 k, carbon	2 w, 10%
R125	180 ohms, carbon	2 w, 10%
R126	Mazda lamp	40 w
R127	15 k, wirewound	25 w
R128	15 k, wirewound	25 w
R129	15 k, wirewound	10 w
R130	2.7 k, carbon	2 w, 10%
R131	47 k, carbon	2 w, 10%
R132	1 k, carbon	1/2 w, 10%

SYMBOL	DESCRIPTION	RATING
Switches		
S101	SPST, tapswitch	
S102	SPST, toggle	
S103	DPDT, toggle	
S104	Modulation selector switch	
TD1	Time delay switch G. Ulanet Co.	Model 115 v AC No. 212
Transformers		
T101	Power transformer	
T102	Filament transformer	
T103	Filament transformer	
Tubes		
V101	6SN7	
V102	6SN7	
V103	807	
V104	5R4GY	
V105	5R4GY	
V106	Neon lamp NE51	
V107	2C39A	
Coupler		
Z101	Micromatch coupler AIL 2110-10B35	

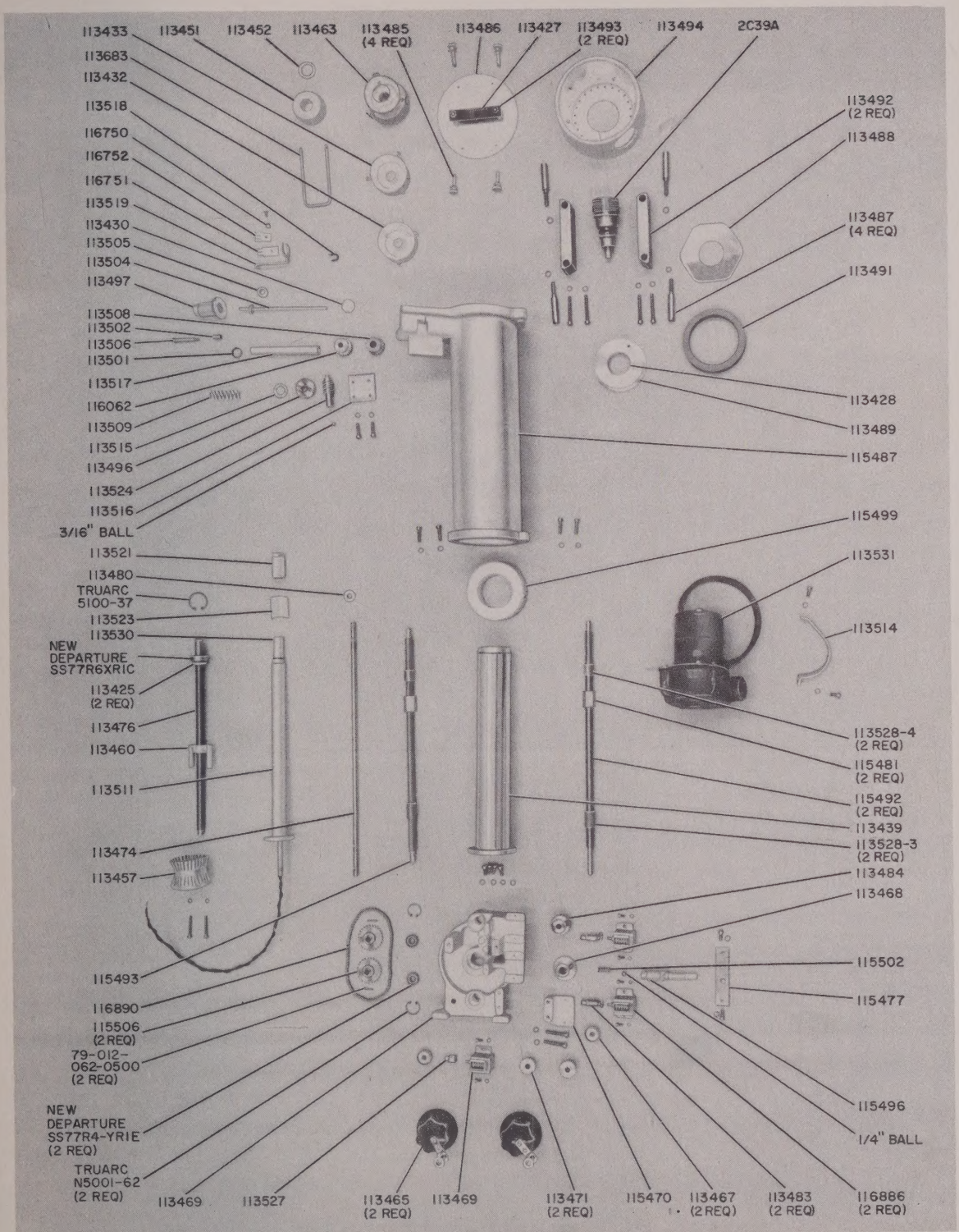
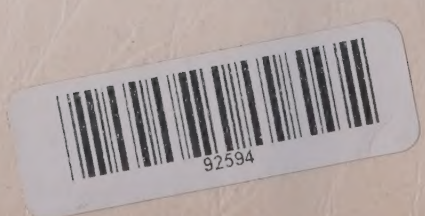


FIGURE 5-1. TYPE 124 CAVITY PARTS IDENTIFICATION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